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NAUTICAL MEDICINE AND HEALTH CARE ON BOARD SHIPS

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Nautical Medicine and Health Care on board Ships

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SYNOPSIS

Nautical medicine is multidisciplinary and has to deal with inland waterway shipping and seafaring. It has curative medical aspects as well as preventive health aspects. Organization and performance of health care on board, mostly rendered by a medical lay-attendant, are a main curative aspect, as are the availability of medical treatment and social contact ashore. Preventive aspects predominantly involve subjects of occupational health like ergonomics on board, accident prevention, work load problems, environmental load factors, social medical problems, hygiene on board and regulations of fitness for duty. Of special concern are search and rescue medicine and the training of medical lay-attendants. Besides these topics the author also presents a short survey of nautical medical history.

INTRODUCTION

> 'More may be done towards the preservation of the health and lives of seamen than is commonly imagined; and it is a matter not only of humanity and duty, but of interest and policy.'

This quotation by Sir Gilbert Blane, the surgeon of the fleet, is taken from his book *Observations on the Diseases of Seamen*, edited in 1779. Nothing has to be added to these words by the famous nautical medical expert. All that should be the objective of all activities today by shipping companies, governmental authorities, shipping associations, unions, federations etc. is summarized in this statement.

HISTORY OF NAUTICAL MEDICINE

From early times doctors had to deal with the special problems associated with seafaring. In the past, much more so than today, sailors were exposed on their long voyages to dangers which hardly existed in the same form on land. For this reason, promoted by a relatively small number of ship's surgeons from the most diverse countries and backgrounds, a specific area developed within medicine some time before there was any talk of specialization. A wide range of valuable treatises from the sixteenth century onwards stemmed from 'medicina nautica'.

Although at that time the Greeks and the Romans were not yet world voyagers, they owned merchant and navy fleets which were quite considerable in number and size. Most of the Roman and Greek warships (triremes and tetraremes) carried medical doctors. The Romans used to call them 'duplicarii' as they got double the pay.

Following the decline of the Roman empire, knowledge about nautical medicine remained in the dark for many centuries, to come to light again in the Middle Ages. During the times of the voyages of exploration in the fifteenth and sixteenth centuries, the environmental conditions for the human beings on board must have been intolerably dreadful for most of them. Everything depended upon building seaworthy deep sea vessels capable of crossing the oceans. Crews had to be enlarged because the greater size of the sails and rigging necessitated more hands. Illnesses and accidents among the crew during months-long unbroken voyages had to be allowed for. Sufficient water and provisions for the lengthy crossings had to be carried. One can imagine how cramped it was on these vessels, normally limited to from 300 to 500 tons and having from 40 to 60 crew members.

These conditions were for the most part to blame in making this period of seafaring history the most tragic chapter in nautical medicine. At that time there were still absolutely no sanitary facilities; in bad weather, leftovers, urine and excrement were tossed into the bilge, where rats and other vermin prospered. An infernal stench resulted, and this putrefying muck was often the source of devastating epidemics. For a long time it was the French and Italian custom to keep the bodies of those who had died on board in the bilge for later burial on land.

Even the biggest ships, e.g. the East India Company's vessel *Dragon* of 600 tons and 300 people on board, showed very poor facilities. The sleeping accommodation was usually particularly bad. Until the famous world voyager Captain James Cook (1728–1779) practised the three-watch system, there were only two watches known. Only enough sleeping space was provided for the men not on duty, in the form of plank beds that were intended for four men, but often had to do for six.

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The death rate on these overcrowded vessels was extremely high, especially in tropical regions. For example, in 1506, a Spanish vessel lost 123 of its approximately 360 men within two months, mostly to malaria. Francis Drake lost almost 600 of the 2300 men under his command in 1585. Particularly tragic was the fate of the English ship *Gloucester*, which in 1617 lost 626 of its 961 men! Especially high losses occurred aboard vessels in the yellow fever areas of West Africa and Central America, sometimes the entire crew, including the doctor, dying and having to be replaced. But nautical medicine, through basic hygiene knowledge, was able to prove the contrary as well. Captain Cook, for example, personally took charge of the medical care, sanitation and general hygiene on the ships in his command. On his first voyage in the Pacific (1768) 23 of the 85 crew members on the flagship died, but on the second (1772–1775) it was only four of 81 men during a journey of 6000 nautical miles. Three perished in accidents, leaving only one single victim of illness.

In general the losses were high. During the sea fighting in the West Indies, 1148 of the 21 608 men of the British Navy were lost in engagement with the enemy, but 3200—well over twice as many—as a result of illness. Thanks to the endeavours of Lind, Blane and Trotter, the three most important British naval doctors, the mortality had decreased markedly by the turn of the eighteenth to the nineteenth century.

In 1760, the rate was still high at 125‰ but by 1810 it had sunk to 50–40‰ and by 1878 to 6.7‰. However, this was still higher than the remarkably low German rate of 3‰, which did not go up even in World War II, when the figure was only 2.55‰ compared with the 2.38‰ who died through enemy action. These figures showed a fundamental change, particularly impressive evidence of the work of ship's doctors. Losses in the merchant marine at this time were still at the much higher level of 10‰. Lind reported in 1760 that, over a two year period, the 5743 patients admitted included those with the following diagnoses:

Fever	2174
Scurvy	1146
Consumption	360
Rheumatism	350
Dysentry and other fluxes	245
Complaints of old injuries	80
Cutaneous diseases	73
Ague or intermittent fever (malaria)	67

This distribution of diagnoses is quite different from the diseases listed today (please see below).

During the past two centuries the standard of hygiene aboard has considerably improved, i.e. lodging, cleanliness, heating, illumination and clothes, particularly since the introduction of iron ships and the steam engine.

Due to modern medical findings the seamen's life on board has become much easier. The previous overcrowding on board vanished in favour of a minimum crew size, with its quite different health problems. The frightening ship diseases like plague, cholera, and smallpox became less prevalent until they practically disappeared. Malaria is still today frightening as an infectious disease, irrespective of the fact that an effective prophylaxis is possible. Avitaminoses like scurvy (Vitamin C) and beriberi (Vitamin B), which formerly took a heavy toll of seamen, have completely disappeared today, predominantly as a result of reasonable nutrition. Nevertheless, some other diseases have remained a severe occupational hazard of seamen, i.e. venereal diseases and seasickness.

Today, seasickness can be looked upon as the only remaining ship-specific disease. According to Roman and Greek references it figured large in seafaring history. In the famous poem 'The Pilgrim's Sea Voyage', which appeared during the reign of Henry VI of England (1422–1471), the main symptoms were accurately portrayed: nausea, vomiting, debility, heart and stomach complaints. Meister Johann Dietz (1675–1738), a German-Dutch ship's surgeon, reported his own experience: 'There was misery and anxiety. There was not one, even 30 years at sea, who was not deathly seasick. I no longer knew who and where I was, quite foolish, with constant vomiting and incontinence, *salvo honore*.'

Remedies were advanced by the thousands, and more than one charlatan filled his pockets. Even though the nausea was not dangerous and claimed no lives, the numerous remedies show what great importance was attached, also in earlier times, to this most typical of nautical ailments. As seafarers know, this condition may still be a problem at sea today.

NAUTICAL MEDICINE TODAY

Modern nautical medicine is multidisciplinary. It covers work on inland waterway as well as deep sea shipping and includes preventive and curative medical aspects (Fig. 1). In spite of all the facilities on board a modern ship, these new technologies bring their own problems. For example, the problem of noise and vibrations on board did not exist in former times. Ergonomic (human engineering) control is needed for heating, ventilation and air-conditioning—especially on board vessels serving tropical areas. Water hygiene on board has always remained a difficult problem. In spite of the tanks available on board to store large quantities of potable water, continuous bacterial control is imperative to guarantee the supply of incontestably pure water. In this connection the application of the so-called low-pressure vaporizers, producing a distillate at 40°C under vacuum, for use as drinking water, is still questionable.

As ships become more automated and crew members fewer, the problem of medical fitness becomes more evident. If a seaman formerly failed for reasons of illness and/or accident, he was easily replaceable by another crew member. This is now rarely possible. Therefore, only applicants who are subject to a comparatively low risk of falling ill or suffering an accident may be fit for duty on board. It is widely but erroneously believed that a ship's doctor will be on board to help a seaman who falls ill. Ship's doctors are now scarce themselves. Only very few passenger and research vessels still carry a doctor. On the majority of cargo vessels world-wide, an officer is usually assigned by the master with the responsible task of medical treatment. In this context, medical treatment means precisely that (not just first aid).

WORK AND LIFE ON BOARD

Most modern vessels are motor ships, with a small proportion of turbine driven steamers. There is an increasing trend towards crew members who can perform a variety of tasks (the so-called multi-purpose crew). The functions of the deck officer and the engineer are generally not yet integrated but this may come in the future.

Between 1960 and 1973, the average number of crew members on board most modern vessels of the industrial countries decreased from about 60 to 25. The trend is for further decrease. Big vessels manned by 20 or even 18 crew members are quite common. The ship of the future is even projected for a crew of only 12 or 14. On board Japanese vessels the crew size will be even smaller and continuously decreasing until the zero-man-ship is reached. It is, however, still doubtful whether the nightmare of remote-controlled international shipping will ever be realized.

The modern techniques of ship-building and the improvement of ship handling in ports brought increased speeds of seagoing vessels and shorter stays in ports. Big tankers and container ships nowadays stay in port for a few hours only. This short turn around time also extends to cargo liners and even tramp ships. Ironically, there are now long delays in some ports in the third world for other reasons and

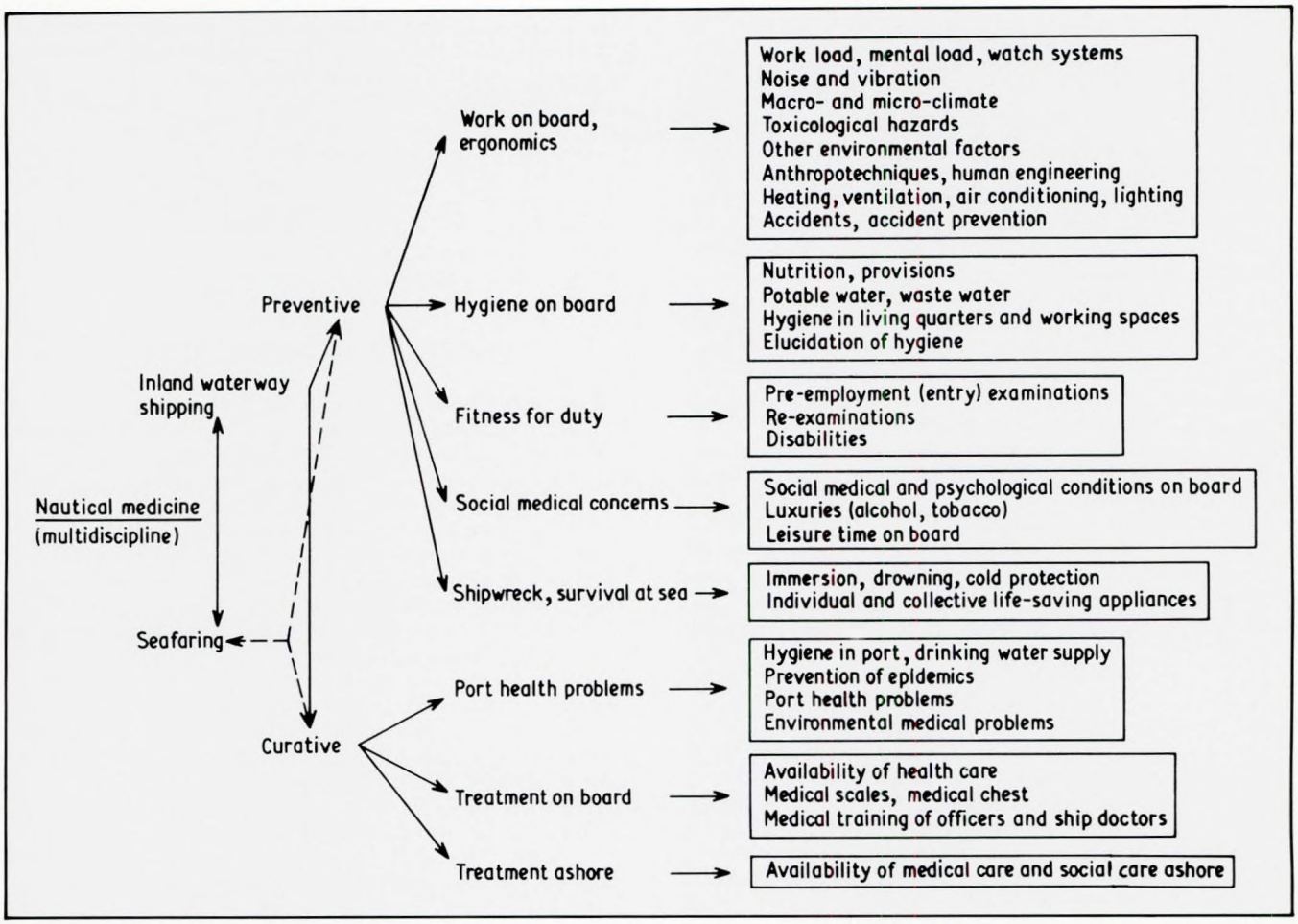


FIG. 1 Schematic representation of the special fields in nautical medicine

this can lead to a stressful burden on personnel. When ships have a quick turn around in special parts of the world with very short lay-times in ports, phases of high work load are naturally involved, particularly for the ship's officers and engineering staff; whereas during long sea voyages with only few diversions, e.g. in the transatlantic traffic, crew members suffer from monotony.

A modern ship's automation has virtually eliminated engine room watchkeeping. The other ship's departments are generally watch-free. This means that the engine room ratings and engineers, in addition to the deck staff, also do normal day work. On most vessels there is only one watchkeeping officer on the bridge. The master, and perhaps a helmsman, appear on the bridge only if the ship is in a difficult situation, in a coastal waterway or approaching a port. The function of the helmsman at sea is generally taken over by automatic devices. The task of the radio officer has not changed essentially, in spite of modern technology. Maybe in future the radio officer will be made superfluous by satellite communication facilities.

Manual work is now only necessary on board some cargo vessels, whilst on container ships such work is required only for short periods or during maintenance. Normally the deck crew has some cleaning and minor maintenance jobs to perform, requiring a moderate physical load but little mental effort. The physical load may, however, increase in some exceptional situation, e.g. states of emergency. The engine room crew has, according to research results, more physical work in maintenance and repair of the engines.

The major problem on board modern vessels with a quick turn around in ports and during long sea voyages is the rapid changes of phases of a high and/or minor work load. Such prolonged periods of isolation can cause psychological problems—particularly as the inactivity may be followed by acute stress and the need for rapid efficient action in an emergency. Thorough research studies have shown that the physical load on board is not normally very high. In special sea areas it may even be extremely low. On the contrary, the mental stress may temporarily be very high for the ship's management and engineering staff, i.e. for deck officers during estuary trading, approaches to ports and in bad weather conditions; and for the engineers particularly during engine defects and temporary repair etc.

HEALTH PROBLEMS RELATING TO SEAFARERS

Fitness for duty at sea

Medical fitness examinations vary greatly world-wide. Some shipping countries do not require any fitness examinations at all; others require superficial examinations only. There are a few countries which legislate detailed and strict fitness regulations. The International Labour Organization (ILO), as early as 1921, pointed to the necessity of medical fitness examinations of young seamen in their Convention No. 16.

Nautical medical experts' attitudes with respect to fitness standards are conflicting. Some countries issue strict fitness regulations stating all health disorders which are to be excluded on board. In other countries there are no regulations available at all, or only rather vague ones rejecting applicants with severe disabilities such as missing

limbs or acute contagious and/or chronic consumptive diseases. Most of the shipping countries clearly define pre-employment and periodic fitness examinations. Although the handling of the pre-employment examination may be strict, the periodic examinations which are provided at one or more years' intervals are less stringent.

Psychological fitness examinations are rare, presumably because no official regulations are available. With the trend towards fewer crew members with reduced physical but increased mental work load, the improvement and/or introduction of fitness regulations becomes more evident in the discussions of nautical medical experts. Contrary to the fact that the larger crews could compensate for fall-out or reduced working efficiency or sick crew members, this is impossible on board modern ships manned with reduced crews of 20 or even less seamen in highly qualified jobs. Improved preventive medical and psychological fitness examinations will, therefore, become considerably more important in the future. Minimum international agreements are not only desirable but imperative. Until today no binding regulations have been issued on an international basis.

In Great Britain, new fitness regulations were quite recently issued by the Department of Transport on the recommendations of the Secretary of Occupational Medicine, Royal College of Physicians. These actual recommendations are very lenient in comparison with previous UK medical standards and with those of other countries, e.g. the German Federal Republic, and permit duty on board with some kinds of health disturbance which, no doubt, may cause difficulties on board later on.

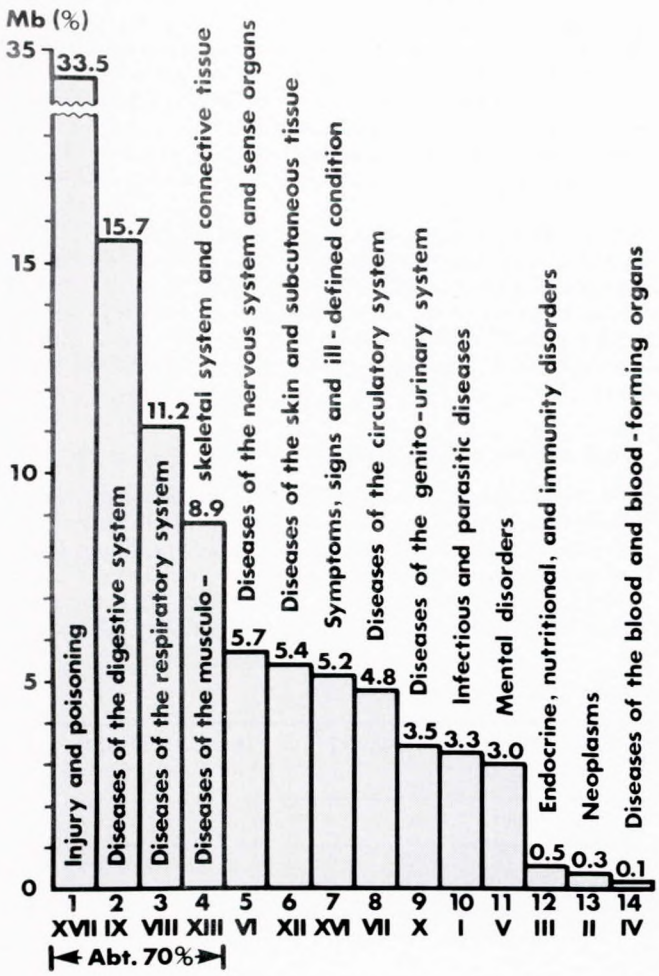


FIG. 2 Sequence of seamen's diseases according to the international classification of diseases from seven countries, 1954–1979

Diseases of seamen

Nowadays one can no longer speak of typical ship's diseases apart from seasickness. Seasickness may be extremely unpleasant for the passengers and seamen on board, though it mostly clears without any sequela when exposure to sea swell ceases. Normally, seamen adapt to these acceleration impulses after a certain time, although there are seamen who suffer each time they go to sea for a new spell of duty.

As far as tropical infectious diseases are concerned, malaria remains a menace to seafarers. In spite of the prophylaxis provided when in the relevant sea areas it is not always adhered to; thus infections may quite frequently be misdiagnosed on board or ashore. Amoebiasis also remains a hazard for seamen, especially the liver complications.

The distribution of diseases which afflict seamen naturally differs in different situations. Sometimes the data base for evaluation is the medical log book on board or the register of outpatient treatment ashore. Unfortunately, there are little data available world-wide. Figure 2 clearly demonstrates that accidents and injuries are at the top of the list of seamen's morbidity, followed by diseases of the digestive system (particularly gastritis/ulcer) and diseases of the musculo-skeletal system (particularly myalgia, lumbalgia, rheumatic complaints etc.).

In deep-seafaring and fishing, dental diseases cause a lot of difficulties. Treatment on board is virtually impossible without a medical doctor and the short lay-times in ports rarely allow time for dental review and treatment. Thus young seamen frequently have missing teeth or full replacement dentures or extensive caries.

Medical care on board

Only a very few vessels world-wide still carry a doctor, so most crew members depend on the medical care of laymen with variable levels of skill. Thus, despite rising medical care ashore, seamen have experienced little improvement in health care at sea. The seafarers are—generally speaking—a population at risk regarding their health. In principle, the possibilities of improvement are rather restricted. There are only three ways:

- Training of personnel in charge of the health care on board;
- Ship's medical scales (content of the ship's medical chest);
- Radio medical advice.

The medical training of shipboard personnel is, no doubt, the most important factor governing health care on board. An excellent ship's medical scale is no good without a reasonably knowledgeable crew member in charge. Furthermore, the standard of the medical scale on board varies world-wide. Many countries do not have individual regulations for the medical scale, whereas others are legally bound to carry excellent medical chests. Most industrialized countries have their own medical chests. A good example is the UK, with the new edition of *The Ship Captain's Medical Guide*. All industrialized and/or advanced countries normally have their own guides. WHO/ILO/IMO published an *International Medical Guide for Ships* which should be compulsory on board vessels of those nations not having individual guides.

Medical care ashore

In his home country a sick seaman normally consults his family doctor or the doctor of his shipping company or agency. He is then treated as an outpatient or admitted to a hospital if need be. In a foreign port, the shipping agencies either arrange a visit of a doctor aboard or send the sick seamen to a clinic ashore. Unfortunately, very often these clinic doctors are not familiar with the peculiarities of nautical medicine. In addition, there may be a language barrier.

English, as the international communication language in shipping, is not understood by all seamen. If the doctor wants to deal satisfactorily with a seaman he should at least acquire some knowledge of specific onboard conditions, in order to be able to decide on the seaman's fitness or unfitness for duty.

As the vessels' stay in port is usually very short nowadays, thorough medical checks and subsequent treatment are rarely possible. At any rate, facilities for quick laboratory tests, electrocardiogram, X-rays etc. must be available. Written medical reports on either the agency's or the doctor's form containing all details with respect to past medical history, diagnosis and laboratory tests should be issued and, if necessary, presented by the seaman to the doctor consulted in the next port. Any seriously sick or injured seamen, of course, should be admitted to a hospital and, if the hospitalization could be long, arrangements should be considered for repatriation.

ENVIRONMENTAL LOAD

Noise and vibration

These environmental load factors have been a problem on board ships since the introduction of the steam engine. Regarding noise, three areas can be distinguished:

- The navigation area with bridge, bridge wing, compass platform and possibly lookout place. This area should be kept as noise-free as possible owing to the need to hear, in a quiet environment, acoustic signals from other vessels by day and night.
- The living and recreational area. The noise level should be low because crew members spend their leisure time here. Even though noise emission from the engine may be insignificant, the noise in this area deriving from neighbouring cabins may represent a serious problem.
- The engine room. The noise level is normally very high, necessitating the wearing of individual hearing protection in order to avoid health impairment. In the engine room on board motor vessels, noise and vibration are predominantly caused by the main engine, including the turbocharger, but may be augmented by the auxiliary diesel engines, compressors and propellers. Propeller noise is particularly difficult to suppress. In shipbuilding it is, therefore, advisable to arrange the superstructure with the crew quarters as far away as possible from the engine room and propeller.

Noise may impair health in two ways:

- Reduction of hearing capacity if the noise affects crew members for longer periods within levels of 85 dB(A) or more. After a certain time, hearing capacity is irreversibly damaged.
- Lower noise levels may also represent considerable stress factors. A noise level around 60 dB(A) may produce a strong load, particularly if interfering with sleep or recreational activity.

Impulse noise is particularly disturbing, e.g. noise on deck caused by loading, repair etc. It involves considerable disturbance to sleeping and recreational capacity, although noise levels are rarely reached which cause a direct impairment of hearing.

Vibrations, which regrettably occur on board nearly all modern vessels, cause direct health impairment very infrequently and only if high intensities are reached. Nevertheless, vibrations represent a big load factor for seafarers. Answers to questionnaires have shown that they rank on top of the list of subjectively perceived loads. The sleeping and recreational capacity may thus be rather limited in the living quarters.

Climate

The term macro-climate signifies the normal environmental climate on board ships. The climate of the different interior areas of the ship is designated as the micro-climate. In a temperate macro-climate, the air temperatures and humidity measured aboard are usually within the 'comfort zone' (Table I). Heating, cooling and humidification of the air are then not necessary. In damp-warm and dry-hot tropical areas (ships operate mainly in damp-warm sea areas), high temperatures become a serious matter, especially if the air humidity is also high. Therefore, vessels operating in tropical areas are, in most instances, equipped with air conditioning plants which predominantly serve the purpose of air dehumidification and, secondly, of temperature reduction. In the colder regions of the southern and northern sea areas, heating is essential.

Modern ship designs have centrally operated air conditioning plants which may supply the individual cabins with dehumidified and cooled air according to the conditions in tropical areas and with heated or untreated fresh air (with or without recirculated air) in colder sea areas. Nearly all vessels, therefore, use artificial ventilation systems which work by means of mechanically ventilated air. The rates of air changes should be carefully adjusted whilst ensuring that air velocity is not too high (maximum 0.2 m/s) at temperatures of about 23°C (Fig. 3).

It is important to realize that ships can, in a matter of days or sometimes hours, move from one climatic extreme to another. Crews may be subjected to considerable thermal stress. In sub-tropical and especially in tropical regions, the environmental thermal stress may be very high. This is especially so in the engine room, the galley and the open deck.

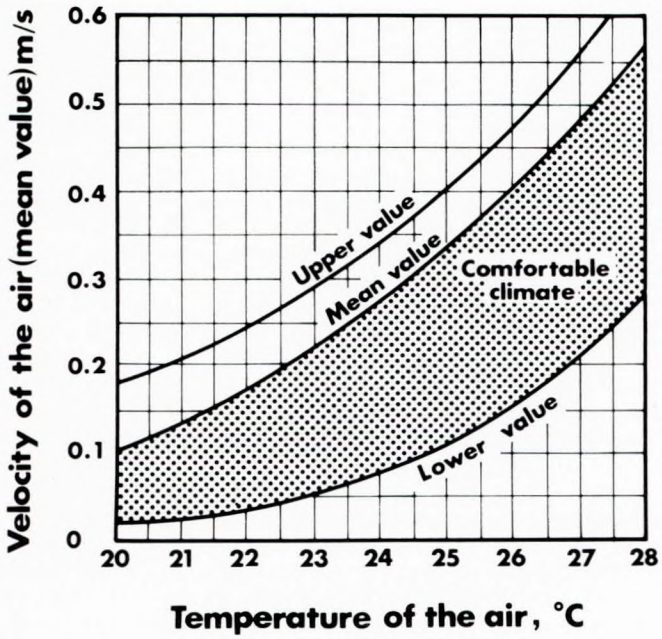
Work regime/watchkeeping

With the exception of the watchkeeping personnel, most crew members only do normal day-work of eight hours per day. Nevertheless, overtime is frequently necessary during repair and maintenance. Watchkeeping is one of the major stress factors which mainly concerns deck officers but nowadays only a few members of the deck staff are involved. On vessels

Table I: Examples of recommended climatic values

KIND OF ACTIVITY	AIR TEMPERATURE (°C)			RELATIVE AIR HUMIDITY (%)			MAX. AIR VELOCITY (m/s)
	min.	*opt.*	*max.*	*min.*	*opt.*	*max.*	
Light office work	18	21	24	30	50	70	0.1
Light hand work in sitting position	18	20	24	30	50	70	0.1
Hand work in standing position	17	18	22	30	50	70	0.2
Heavy work	15	17	21	30	50	70	0.4
Heaviest work	14	16	20	30	50	70	0.3

Note: The difference between the room temperature and the temperature of the surface of the environmental objects and walls should not exceed 2°C for optimal air-conditioning.
Source: W. Lange, J. H. Kirchner, H. Lazarus *et al., Kleine ergonomische Datensammlung.* Verlag TÜV Rheinland, Köln (1981).



Note: For normal application in human comfort environment the occupied area is geometrically limited to 0.15 m from all room surfaces with a height of 1.80 m above the floor.
Source: 'Shipbuilding—Air-conditioning and Ventilation of Accommodation spaces on Board Ships—Design Conditions and Basis of Calculations'. Draft International Standard ISO/DIS 7547. ISO/TC 8. 1984-03-29.

FIG. 3 Air movement in occupied areas according to ISO/DIS 7547

having the three watch system, which consists of four hours on/eight hours off, normally one officer and, on most ships, one seaman are on duty. On small vessels the two-shift watch system is usually practised, i.e. six hours on/six hours off. On board some vessels the watch rhythm is six hours on/four hours off, followed by four hours on/six hours off and so forth. This, however, means a continuously shifting working time. The watchkeeping on board, representing the oldest form of shift work, is, no doubt, a large but poorly documented stress factor.

The rapid East–West trading represents an additional stress factor, e.g. on board fruit-carriers and container vessels. Considerable time shift, possibly with 'jet lag', are the result. The time may shift until a maximum of one hour per day is reached. The resulting load on the crew member, particularly the watchkeeping personnel, is the subject of a research project in the Federal Republic of Germany. The immediate duty on board after long flights from East to West or West to East, e.g. in case of duty after holidays, is a precarious factor because of the considerable adaptation problem after 'jet lag'.

Toxic hazards/dangerous substances

The risk of toxicological accidents caused by dangerous cargo is rather high on board chemical tankers, but decreases in the sequence of crude oil tankers, dry cargo vessels and container ships. Most toxicological accidents and/or poisonings, however, are not caused by dangerous goods but by chemicals used on board, such as detergents, cleaning substances, solvents, gases, additives etc. This is unexpected and forces all to recognize the hazards deriving from such working substances.

Fundamentally, poisoning may be caused by swallowing, inhalation and skin contact. It is an often neglected fact that, besides the chemical burns by, for example, acids and alkalis, the intact skin may be pervious to some special kinds of chemicals. So phenol skin contact may lead to serious general poisoning.

Some of the chemicals used on board vessels are the following:

- *Detergents:* These remove the fat from the skin and, if continuously used without protective gloves, may produce dermatitis and eczema of the hands. These diseases are thus often to be found in stewards, cleaning staff etc.
- *Solvents:* The same hazards as above apply to solvents. Besides dermatitis and/or eczema, poisoning may occur. Most solvents produce a fairly high gas pressure: the liquids evaporate very easily, thus representing potential poisoning by inhalation. The hazard naturally increases in closed rooms. Most gaseous solvents, if inhaled in sufficient concentrations, lead to impaired cerebral function with dizziness and lack of restraint, and possibly unconsciousness and death. The clinical picture may be similar to that of alcoholic poisoning. Furthermore, damage of the organism, particularly the kidneys and liver, may result.
- *Acids and alkalis:* Skin contact may result in severe chemical burns. Frequently these substances are carelessly kept in unlabelled bottles normally used for beverages. If swallowed by mistake they cause severe chemical burns of the oesophagus and the stomach, possibly followed by severe disability or death.
- *Additives:* Various kinds of additives, e.g. hydrazine, tribasic phosphate etc., are used in the engine room. These substances are always toxic but there is no potential hazard by inhalation. Protective gloves and glasses should be worn in any case when handling these substances.
- *Gases:* Exhaust gases from the boiler and engine plants contain high concentrations of carbon monoxide (CO), carbon dioxide (CO_2) and also nitrogenous gases as well as sulphur dioxide (SO_2). Inhalation must be strictly avoided. CO may cause death very quickly as it blocks the transportation of oxygen in the blood. NO_x and SO_2 are toxic gases acting on the lung, causing lung oedema and suffocation.

  In fire extinguishing systems the involuntary leakage of CO_2 may quickly cause poisoning. Very often it is forgotten that tanks and organic cargo like fruit, vegetables, grain etc. may contain and/or produce CO_2. The gas is considerably heavier than air. It concentrates at floor level and in sufficient concentration leads to suffocation because of its ability to displace oxygen.
- *Asbestos:* Big quantities of this material have been used in shipbuilding world-wide. The material itself is not toxic but its dust, even in low concentrations, may cause severe impairment of the respiratory function if inhaled. Even cancer-like malignancy of the lung may result. Also, exposure to minor concentrations may be followed many years later by diseases. Therefore, asbestos should possibly not be used in future shipbuilding.

SUMMARY OF LOAD FACTORS

Investigations of the total individual load on crew members, caused by the accumulation of environmental factors such as ship's movement, vibrations, noise, climate, heat, radiation, insufficient lighting, chemicals and high frequency radiation, showed that the main factors of load are the ship's movement, vibration, noise and sometimes the macro- and micro-climate. By contrast, high frequency radiation, insufficient lighting and chemicals do not figure large.

The physical work load is in general not very high; the mental work load may be high for the master, the deck

officers and the engineers in special situations. Fatigue and boredom can be regarded as a specific load factor in seafaring.

HOW TO KEEP FIT AT SEA

General aspects

> 'Seafaring people are that class of mankind who are supposed to be in perfect health when they enroll themselves for any particular voyage or cruise; notwithstanding their hardiness, they are liable to many and numerous excruciating maladies . . . Sailors are very apt to become careless of their health, especially while in port, and expose themselves to every intemperance that can possibly produce the occasional causes of disease.'
>
> *Samuel H. P. Lee, M.D. and Apothecary, 1795.*

It is a difficult struggle for seafarers to keep their physical and mental fitness. There is a remarkable lack of space for exercise on board modern vessels. Owing to the reduction of manual work, physical fitness normally decreases. Monotony and isolation from the social life ashore frequently produce withdrawal symptoms during long voyages at sea. Sporting activities are seldom organized on board vessels. Only a comparatively small number of seafarers force themselves to regular physical fitness training in the form of jogging, gymnastics etc. Table tennis seems to be more popular and in ports, if it can be managed, football matches against teams from other vessels or ashore.

There are only few crew members who use the short lay-times ashore for physical training, e.g. jogging or longer walks etc. There is either a lack of time or it is spent in some doubtful distraction which does not improve fitness but on the contrary often leads to illness.

During long voyages in tropical areas away from cool climatic conditions, an absolute lack of physical hardening may result. Owing to insufficient physical training and the lack of physical hardening, the seafarers may easily contract infectious diseases like colds, influenza etc.

Meals in ports with a low standard of hygiene naturally involve a potential hazard of communicable diseases. Amoebiasis, typhoid, paratyphoid and a great many salmonelloses transmitted by contaminated food and beverages endanger the health of seafarers.

To keep the seafarer fit, the following medical recommendations are made:

- Physical hardening as far as possible, massage of the skin with brushes, alternating hot and cold showers.
- Regular physical training on board, brisk walking and jogging instead of the use of bicycle on board big ships, use of staircases instead of lift.
- Sporting activities on board such as gymnastics, possibly swimming, or table tennis.
- Regular review of training programmes with respect to increased physical requirements.
- No use of taxi ashore; brisk walking and jogging.
- If possible no tobacco and no alcohol.
- Reduction of any overweight.
- The prevention of overnutrition with limited fat and protein and a good mixed diet of low calorific content.
- Utmost caution with meals ashore in countries with a low standard of hygiene (eat only food cooked and fried above 100°C). Salads may be a source of infections like helminthiasis, amoebiasis, bacterial and communicable diseases.
- No drinking during meals, slow eating, thorough chewing to keep the gastric acid barrier to prevent infectious diseases.

Food and food handling

> 'Serve God daily, love one another and preserve your victuals.'
>
> *Sir John Hawkins, 1562 (advice to his crew prior to embarkation).*

In contrast to the times of sailing vessels and early steamships, physical work has decreased and food quality has considerably increased. The latter is due to modern preserving and deep freezing techniques. There is an excessive supply of protein, carbohydrates and especially fat. Perhaps the variety of food is meant to offset the monotony of the voyage! Thus seamen who, in former times, were frequently malnourished are now often obese.

A wide selection of drinks is available—mostly tea, coffee and sometimes milk. Coffee is served not only after meals but also during the watchkeeping duty. Beer, lemonades, Coca-Cola etc. are normally sold to the crew members. The excessive drinking of iced mineral water, beer etc., as well as of cooled water from the drinking fountains, can cause gastric problems in the tropics.

The hygiene training of cooks varies with their ethnic origin and that of the crew. Not infrequently they were butchers or bakers ashore before going to sea but they are frequently ill prepared for the special catering requirements of life at sea.

The inevitable limitations on space make the provision of sufficient refrigerated storage very difficult, while the variation in ambient temperature often makes generous refrigerated space absolutely essential. The general rules on the temperatures at which food should be held can be summarized as follows:

- All frozen food: below −18°C
- Milk, cream and all goods containing them: +6°C
- Raw meat, poultry and fish (for *short* periods): below +6°C
- Manufactured or pasteurized meat or meat products: below +6°C
- Fruit and vegetables: +6−10°C

With the exception of canned or otherwise preserved food and of fruit and vegetables, food must not be left at temperatures higher than +6°C for any longer than absolutely necessary. There is always the imminent danger of bacterial contamination.

Strict food hygiene is essential on board to preserve the health of seafarers by avoiding gastric infections.

Water supply

In some vessels there are still three different water systems available on board for the supply of:

- potable water;
- non-potable water (so-called fresh or wash water);
- sea water.

This used to involve three individual plants, whereas modern ships now normally have two independent plants for the supply of potable water and sea water. In order to simplify matters, attempts are being made to develop one standard system which will also include the flushing lavatories. Water systems for technical consumption should be strictly separated from potable water systems, e.g. vacuum breakers, free air gaps.

The total water consumption (potable, wash and non-potable water) is enormous and may exceed 300 litres per person per day in tropical areas. All water taps in galleys, pantries, hospitals, wash basins, showers and stores should be connected to the potable water system. Such water is usually taken on board in port and should be stored in special tanks with solid concrete or other impervious lining. Nowadays, many vessels produce potable water by distilling sea water by means of low pressure vaporizers. Permanent disinfection is necessary in this case. Water supply on board represents a

formidable hygiene problem. Bacterial contamination happens quite frequently and is often due to inadvertent mixing with waste water. Reassessment of bacterial control should be performed at least annually and is generally available from the port health authorities.

The water quality on board must adhere generally to the drinking water standards ashore.

Survival at sea

> 'Sea lies all around us . . . . In its mysterious past it encompasses all the dim origins of life and receives in the end, after, it may be, many transmutations, the dead husks of that same life. For all at least returns to the sea—the beginning and the end.'
>
> *Rachel Carson, The Sea Around Us, 1951*

The medico-technical problems in case of shipwreck are manifold. On board, there are two systems of lifesaving appliances which should be available:

- The individual lifesaving appliances such as lifebelt, life-jacket, life-buoy, survival suit;
- The collective lifesaving appliances such as lifeboat, life-float, inflatable life-raft, rescue satellite.

Life-jacket technology has been continuously improved. The jacket should ensure that the nose and mouth of an unconscious or exhausted person are kept above the water during heavy seas whilst also providing general buoyancy.

According to the requirements of the SOLAS Agreement, chapter 33, survival suits must in future be available in sufficient number for all crew members on board in order to prevent hypothermia. In the German Federal Republic they have been compulsory on board since October 1983. Quite a number of different models of survival suits which have passed strict IMO trials are now being offered world-wide. In addition, the body temperature of the person wearing the survival suit must not drop by more than 2°C during exposure in water with temperatures between 0 and 20°C for six hours. It has been found in search and rescue operations that most of the shipwrecked victims die from hypothermia, either in the water or subsequently to the rescue.

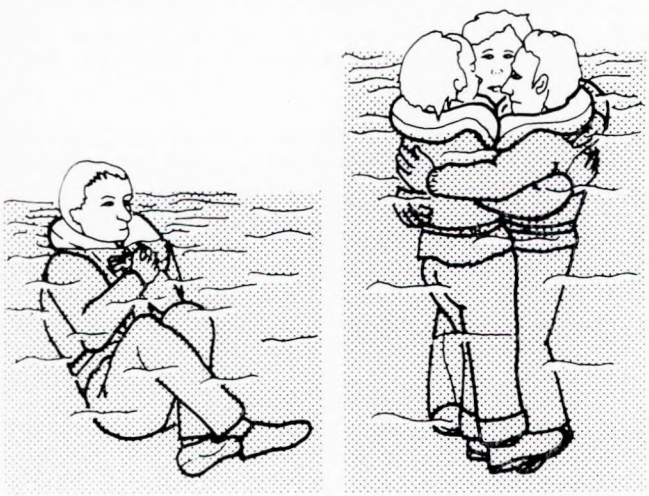
Life-boat design has developed rapidly in recent years. Open or uncovered boats mostly offer only little shelter during bad weather. Therefore, covered or completely closed boats are now commonly supplied. The development of free-fall boats and/or rescue satellites has advanced enormously. In several countries, e.g. Norway and the German Federal Republic, they are already available on board.

When abandoning a ship the following practices should, if possible, be observed in cold water with temperatures below 20°C:

- To put on warm clothes of any kind including boots, cap, gloves, overcoat if no survival suit is available; otherwise wear a survival suit.
- To drink ample hot and possibly sugared liquids.
- Not to forget to put on a life-jacket.
- To slide into the water, jumping only if need be.
- If jumping is unavoidable, to cross arms in front of chest, thus seizing the life-jacket (avoiding the hazard of knock-out blows under the chin from a rigid life-jacket).
- Minimum movement in the water: no swimming, no crying and no agitating in order not to lose body heat and energy unnecessarily.
- To stay in the HELP position (heat exchange limitation position, Fig. 4), with companions closely together in the water.
- To keep quiet in the boat.
- To adhere strictly to the instructions of the commander of the life-boat.
- To stay closely together in life-boat or inflatable life-raft to prevent hypothermia.
- In case of extended stay in the boat, the emergency provisions and the stock of potable water should be used strictly according to the instructions to be found on board.
- Seasickness in the boat and particularly in the life-raft is unavoidable; if possible, take up a flat position and/or avoid eye contact with the environment.

FIG. 4 Heat escape lessening position (HELP)

Source: A. Low and H. Goethe, *Medical Problems and Search and Rescue*, p. 45. Schiffahrts-Verlag Hansa, Hamburg (1978).



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Discussion

Surgeon Captain E. P. BECK (Institute of Naval Medicine): Professor Goethe's paper seeks to encompass and comment upon nautical medicine past and present. It concentrates on civilian affairs but refers to military naval medicine in the historical section.

Military nautical medicine has its own distinct features, which in some ways parallel civilian experience. Warships ships' companies are densely populated in relation to other vessels, although crew numbers are reducing with increased ship sophistication and the trend is towards higher standards of habitability. A 5000 ton warship of World War II would perhaps have had a complement of 450, whereas a similarly sized vessel today might carry only 200, many of whom are specialists.

On board warships the provision of doctors and the scale of medical stores carried depends upon such factors as the political situation and distance from support. Royal Navy warships of frigate size and above carry medical assistants who are specially trained paramedics. In smaller vessels non-medics with some training are responsible for health. Military nautical medicine includes the areas mentioned by Professor Goethe but also covers such diverse topics as toxicology of military materials, submarine medicine, damage control and casualty handling, battle stress, and aspects of diving medicine and aviation medicine, to name but a few.

Medical and dental checks, to specific guidelines, are regularly carried out on Royal Naval personnel in an endeavour to prevent problems at sea and to ensure fitness for work.

A standard method of record keeping enables contintuity of medical care of personnel moving between ships of the Fleet.

The Royal Navy is actively investigating improved medical signalling techniques and the use of computer assisted diagnosis.

On board warships noise, vibration, explosion risk, radiation and toxicology must all be considered. Although the problems associated with heat exposure are dealt with, seamen working on the upper decks in the North Atlantic may be exposed to extreme cold. Submarines have to be able to monitor and control their internal environments, possibly for months at a time. Additional loading arises from the complexity of the modern fighting unit, the constraints of naval discipline and busy ships' programmes.

Although fitness of seagoing personnel is of importance to the Royal Navy, such ideas as 'hot and cold showers', 'massage of the skin with brushes' and 'thorough chewing' to prevent infectious diseases could not be endorsed without supporting evidence of efficacy. Multi-gyms and physical-training instructors are often carried on British warships.

Is there evidence to support the reported gastric problems resulting from excessive drinking of cooled drinks?

The water supply is often restricted on board small submarines and can lead to difficulties in the maintenance of personal hygiene. The Royal Navy has no problems with water purification by distillation.

The subject of survival at sea has been extensively researched by the Royal Navy. Survival suits are intended to keep out water. However, to be effective as preventers of hypothermia, extra layers of warm clothing worn underneath the suit are required. Royal Navy lifejackets have hoods to help prevent drowning. Drowning is often a contributory cause of death after immobilisation by hypothermia. All Royal Navy warships are provided with inflatable, covered liferafts as primary survival aids. When abandoning ship becomes necessary, there is unlikely to be time to take 'hot drinks', even if such a procedure could be shown to be beneficial. Lifeboats may not be conveniently placed and may be inoperative in burning or heavily listing vessels.

Professor Goethe's paper develops in a logical way but at times presents contradictory statements. Some of the specific recommendations made seem to be based on myths and misconceptions about naval service.

R. G. BODDIE (IMarE, Secretariat): I would like to draw the attention to Merchant Shipping Notice No. M1114 on the Merchant Shipping (Medical Examinations) Regulations 1983, SI 1983, No. 808 which were reviewed recently by a working party set up by the Faculty of Occupational Medicine of the Royal College of Physicians. Medical examinations for seafarers are a statutory requirement and Merchant Shipping Notice No. M1121 lists approved medical practitioners and approved medical referees.

Seafaring is a potentially hazardous occupation which calls for a high standard of health and fitness for those entering the industry. Notice No. M1114 states: 'A satisfactory standard of continuing good health is necessary for serving seafarers throughout their career because of the high inherent risks of the occupation. It is better, therefore, at an initial examination, to exclude an applicant if there is any doubt about his continuing fitness. Flexibility should be exercised only during examinations for retention'.

Frequency of medical examinations in the UK Fleet are:

1. Annual for those below the age of 18.
2. Not exceeding 5 years for those between 18 and 40 years old.
3. Not exceeding 2 years for those over 40 years old.
4. Annual for those serving in bulk chemical carriers with annual blood tests, or at more frequent intervals depending on the nature of the cargo.

In his talk Professor Goethe commented on the poor food and appalling conditions that the crew were subjected to in the days of sail. It is interesting to note that a recent examination of the skeletons recovered from the *Mary Rose* off Portsmouth showed that the crew were of similar height to UK inhabitants of today and that although the sailors had good teeth, the officers had bad teeth, which was put down to the fact that the latter could afford to purchase sweetmeats.

There are so many different diets published today that it is difficult for the layman to know how to eat sensibly. For example, an acquaintance who is married to a general practitioner recently felt below par and two consultants later she was told that she was suffering from an excess of fibre in her diet, which leeched out of her system important trace elements. Could the author comment on the dangers from too much fibre in the diet?

J. W. BOWDEN (Medical Adviser, Ocean Fleets Ltd): The author gives a clear and comprehensive account of the health problems relating to seafarers today and his recommendations for medical care at sea, with which I fully agree.

In my opinion, the present provisions for the care of the sick and injured on British cargo ships is a reasonable compromise between the ideal (i.e. having a doctor on board) and what is economically and environmentally practicable.

The new *The Ship Captain's Medical Guide* is well illustrated and clearly written. It covers most of the illnesses and injuries that are likely to be encountered at sea, and how to recognise and treat them within the facilities available.

The current Board of Trade Merchant Shipping Medical Scales I, II and III of medical supplies are adequate for the vessels to which they apply.

The Chemicals Supplement to *The Ship Captain's Medical Guide* contains a list of additional medical stores for ships carrying dangerous chemicals and instructions for the

prevention and treatment of poisoning due to them.

I agree with Professor Goethe's concern for the medical training of shipboard personnel responsible for the health of the crew. This could be improved. Shipmasters and Chief Officers of British ships are required to take a course of 16 h of lectures and practical demonstrations, based on *The Ship Captain's Medical Guide*, to obtain their compulsory Medical Training Certificate.

The weakness of this system is that care of the sick and injured is not undertaken by these Officers who have had the training, but is delegated to Catering or other Officers who have not.

If these other Officers are to perform these duties, I think they should have the same medical training that is prescribed for Captains and Chief Officers. They should be required to obtain the same Medical Training Certificates.

It would also be advantageous for them to attend a short refresher course, say every five years. Such courses are available in Liverpool (*vide* GCBS General Circular No. 5 dated 1st February 1984, para. 3).

Incidentally, I approve of The Merchant Shipping (Medical Examination) Regulations published in the Department of Transport Merchant Shipping Notice No. M1144 in August 1984. These should eliminate many who are at risk of becoming medical casualties at sea.

Professor R. I. McCULLUM (Medical School, University of Newcastle upon Tyne): I have three brief comments to make on Professor Goethe's very interesting paper and well illustrated presentation. First, I was reminded of the experiments of the late Professor Pask, who was a colleague in Newcastle some years ago. He had himself anaesthetized and thrown into the water unconscious in order to test devices designed to support the human body with the face out of the water. Has Professor Goethe considered experiments of this type, and would they be justified?

Secondly, in testing survival suits would it be possible to do so in very rough water rather than in still water, as appeared in the slides. Clearly there would be technical problems in monitoring individuals taking part in such experiments.

Finally, to what extent can health education for seafarers deal with cigarette smoking and alcohol consumption, in both of which there must be great temptation to overindulge. These factors are now recognized as being of great importance in the population at large in relation to heart disease and other common illnesses.

Table DI: Deaths of UK crews, 1974–1983

Cause	*Number*	*%*	*Yearly average*
Casualties to ships	183	12.3	23.3
Accidents on board	306	20.6	34.0
Accidents ashore when abroad	131	8.8	14.5
Social problems (homicide, suicide, missing at sea)	179	12.0	19.9
(sub total)	(799)	(53.7)	(88.8)
Heart problems and other diseases*	686	46.3	76.2
Total	1485	100.0	165.0

*Diseases: coronary = 68%, other diseases = 32%.

Table DII: UK ship deaths other than from disease

Cause	*Total 1983*	*Total 1982*
Casualties to vessels		
Founderings	0	5
Strandings	0	0
Collisions	0	4
Missing vessels	0	0
Explosions, fires	1	9
Others	0	16
Total	1	34
Other accidents		
Engine room	2	0
Falls from aloft	0	0
On deck	4	2
Fell down hatch	3	0
Fell overboard	3	2
Washed overboard	0	0
Killed or drowned coming aboard	4	3
Drowned in dock	1	7
Killed or missing ashore	1	4
Homicide	0	1
Suicide	1	2
Missing at sea	1	5
Other causes	0	5
Total	21	33
Grand total	22	67

Dr J. COWLEY (Surveyor General, Department of Transport): Professor Goethe is to be congratulated on producing a paper on the major causes of death on ships. I intend to produce statistics relating to UK ships which show that deaths due to disease are about 4 times greater than deaths due to casualties.

However, I will first comment on the sole area of disagreement with Professor Goethe. This disagreement relates to the second paragraph of page 5 of the paper, which suggested that the Department of Transport's medical regulations were very lenient compared with those of some other countries. Our understanding is that very few countries published mandatory medical standards and I would be interested if Professor Goethe could provide some information on the mandatory medical standards of the major seafaring nations.

The position in the UK until 1983 was that the only standards for medical fitness were those voluntarily set by the General Council of British Shipping. The Merchant Shipping (Medical Examination) Regulations 1983, SI 1983, No. 808 introduced statutory standards for UK ships above 1600 gross tons. These standards were very inflexible and at the request of Mr David Mitchell, Minister with special responsibility for shipping, a working party was set up by the Faculty of Occupational Medicine of the Royal College of Physicians to 'Review the Application of the Medical Standards for Seafarers' in December 1983.

As a result of the recommendations of this working party, the Department published revised Medical Standards for seafarers in Merchant Shipping Notice No. M1144 (issue 3). The new standards were framed to provide maximum flexibility in their interpretation compatible with the maintenance of the safety of vessels at sea, the safe performance of the seafarer's duties and the safeguarding of his health. The application of these regulations to ships less that 1600 gross tons is still at the consultative stage.

In relation to points arising in Professor Goethe's paper, the following details relating to UK practice and experience may be of interest:

1. Doctors are required on Middle Trade and foreign-going ships carrying 100 or more persons (crew and passengers etc.)
2. Certified cooks are required on Middle Trade and foreign-going ships over 1000 gross tons.
3. The Department of Transport has detailed procedures for the testing and approval of fresh-water generators for producing drinking water at operating pressures less than atmospheric.
4. From our records, toxic substances do not constitute a significant death hazard.

The following statistical information may be of interest. Table DI summarises deaths of UK crews for the 9 year period from 1974 to 1983. Several points might be noted. The number of lives lost due to social problems at 179 is almost equal to the lives lost due to casualties to ships (i.e. fires, collision, foundering etc). Furthermore, accidents ashore when abroad constitute a significant proportion of the deaths.

Table DIV: UK yearly analysis of deaths from all causes, 1973–1983

Cause of death	*1973*	*1974*	*1975*	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*
Casualties to vessels											
Founderings	6	7	24	—	—	—	12	1	11	5	—
Strandings	—	—	—	—	—	—	—	—	—	—	—
Collisions	3	—	1	—	—	5	—	—	—	4	—
Missing vessels	—	—	—	8	—	—	—	42	—	—	—
Explosions and fires	6	6	7	5	3	3	4	2	1	9	1
Others	4	—	1	1	—	—	3	—	1	16	—
Total	19	13	33	14	3	8	19	45	13	34	1
Other accidents											
Accidents on board	30	34	38	32	37	63	28	22	25	10	17
Accidents ashore	31	30	27	14	3	6	11	16	6	15	3
Homicide	2	7	4	6	—	2	—	1	1	1	—
Suicide	13	17	22	4	6	4	5	4	3	2	1
Missing at sea	22	11	6	12	12	13	8	12	6	5	4
Disease	110	118	105	65	71	74	55	67	51	39	41
Total	208	217	202	133	129	162	107	122	92	72	66
Deaths per 1000 seamen at risk		n.k.	2.2	1.4	1.4	1.9	1.5	2.1	1.5	1.6	1.2

Table DIII: UK ship deaths from disease

	Total 1983	*Total 1982*	
Rank			
Deck officers	6	8	
Apprentices, cadets	0	0	
Engineer officers	3	6	
Radio officers	0	1	
Deck ratings	10	14	
ER ratings	7	1	
Catering ratings	11	7	
Miscellaneous	4	1	Average 1974–1983
Total	41	39	76.2
Age groups (years)			
Under 20	1	0	
20 to 24	0	2	
25 to 34	4	1	
35 to 44	4	5+2=7	
45 to 54	20	13	
55 to 64	11	16	
65 and over	1	1	Average 1974–1983
Total	41	39	76.2

However, the major cause of death is disease, yielding 686 deaths during the period. Of these 68% are in the coronary category.

Table DII gives a detailed breakdown of the UK ship deaths from causes other than disease for 1983 and 1982. The year 1983 was unusual in that only one life was lost due to casualties to vessels. The previous best year in recent times was 1977 when 3 lives were lost due to casualties. Table DII shows that a significant proportion of 'other accidents' relate to seamen being killed or drowned when coming aboard and drowned in the dock. Missing at sea is also a significant category.

Table DIII categorises UK deaths from disease for the years 1982 and 1983 under rank and age group. Apart from the apprentice and cadet category, catering ratings form a lesser proportion of the crew of a ship than the other categories listed yet they constitute a higher proportion of deaths from disease than do for example deck or engineer officers. It therefore appears, on the albeit limited statistical information, that they have a higher possibility of death from disease than do other members of ships crews.

Table DIII also appears to indicate that the 45–54 year age group is most susceptible to disease. This might be expected considering the previous indication that 68% of the disease deaths were due to heart problems.

Table DIV gives a complete breakdown of deaths from casualties to British ships for the 11 years 1973–1983. It shows clearly that deaths from casualties to ships form a small proportion of the total and that disease is the major cause of death at sea. The statistics appear to indicate that the tendency towards suicide at sea is lessening and that same trend is evident in the 'missing at sea' category.

Table DV shows the breakdown of deaths among crews from disease, giving the nature of the disease and the age group.

I would like to ask Professor Goethe whether these UK statistics are (a) similar to those in other countries' fleets and (b) similar to those for shore workers.

Dr D. DEAN (General Council of British Shipping): Professor Goethe is a well known colleague and expert in the field of nautical medicine, and his paper is most interesting and timely in describing the current position regarding the health of seafarers. Little dissension would be found with the content of the paper and the views expressed, although workers in this country would perhaps place the stress and emphasis rather differently.

It would be useful at this stage, however, to clarify the situation regarding the UK Merchant Shipping (Medical Examination) Regulations which were introduced by the Marine Division of the Department of Transport on 1 July 1983. These were based on the original GCBS voluntary code and standards for the medical examination of seafarers and not at this stage with any reference to the Royal College of Physicians. The legislation also only applies to serving seafarers and the existing GCBS Standards continue to be used for entrants to the shipping industry in the federated sector.

A Working Party drawn from the Faculty of Occupational Medicine of the Royal College of Physicians did, however, review the medical standards for serving seafarers during the first year of operation. The revised standards allowed examining approved doctors rather more flexibility in making decisions about medical fitness for a small number of specific conditions but the overall philosophy was preserved.

It is not quite accurate therefore to aver that the revised standards are now much more lenient than hitherto, but the important point is that the standards are now uniform and legally enforceable when previously this was not the case.

I would query whether seasickness, malaria and typhoid are really occupational diseases of seafarers, since the former is controllable and the latter two tropical diseases are not confined to seafarers.

British statistics are now becoming available and are published in the first edition of NMB Digest of Accident and Health Statistics. They reproduce Professor Goethe's European experience with regard to the prominence of deaths and disability from accident. But both mortality and morbidity experience from disease in UK seafarers are accounted for predominantly by cardiovascular disease (49% of deaths). This at variance with details given in Professor

Goethe's Fig. 2, which ranks circulatory diseases as a low eighth in the table. The UK experience for seafarers is in conformity with the national average for all males in England and Wales for similar groups.

R. M. DUGGAN: This is a particularly interesting event as it is the first time that a medical paper has been read to the Institute and such a paper is long overdue as engineers and medical doctors must work much closer together.

During the early part of my career considerable effort was directed towards solving engineering research problems and virtually no thought or effort was directed towards the medical aspects or consequences. Sometimes, quite by chance, some connection would develop. For example, whilst the prototype marine gas turbine was being tested for fuel compatibility, a medical doctor of the British Thompson Houston Co. found quite by chance a connection between the hazards of flourescent tube manufacture (berrylium) and some of the deposits we were finding on gas-turbine high-temperature blades (vanadium compounds).

Frequently, medical aspects are only investigated after an accident, but in more recent years considerable thought and effort has been put into evaluation and investigation of medical aspects while engineering research is in progress. A good example is the polyurethene foam work for low-temperature liquid-gas transportation.

Some members of the audience will no doubt be aware of a Committee of the House of Lords which is seeking opinions and suggestions at the moment for research, and this Institute has been asked for suggestions.

In my experience it is often very difficult to find a medical specialist or expert in a particular field. I am convinced that in this country such a person often exists but is difficult for another discipline (such as engineering) to find.

An example that comes to mind is the project my company undertook to try to evaluate scientifically the effects on people of noise and vibration in ships (using the technique of measuring the ketosteroid level). We sought medical advice and direction, a considerable grant was provided by the SRC for equipment, and the work was undertaken by the Acoustic Physics Department of Salford University. After 3 years the work was proved clearly inadequate and no useful results were obtained.

With these experiences in mind I am therefore interested to have Professor Goethe's comments on whether a useful project could be developed on how to harness the expertise in the medical sphere to engineering research.

J. KINAHAN (National Union of Seamen): The subject of Professor Goethe's paper is nautical medicine and health care

Table DV: Deaths among crews from disease in 1983: nature of disease and age groups

Nature of disease	*British subjects*	*Foreign subjects*	*Asian seamen*	*Age groups* (years)							*Total 1983*	*Total 1982*
				Under 20	*20 to 24*	*25 to 34*	*35 to 44*	*45 to 54*	*55 to 65*	*65 and over*		
Ineffective and parasitic diseases												
Malaria (including blackwater fever)	—	—	—	—	—	—	—	—	—	—	—	—
Neoplasms												
Cancer and malignant tumours etc.	—	—	—	—	—	—	—	—	—	—	—	1
Endocrine system, metabolic and nutritional diseases												
Diabetes	—	—	—	—	—	—	—	—	—	—	—	1
Diseases of the blood and blood-forming organs	—	—	—	—	—	—	—	—	—	—	—	—
Mental, psychoneurotic and personality disorders												
Alcoholism	—	—	—	—	—	—	—	—	—	—	—	—
Diseases of the nervous system and sense organs												
Cerebral haemorrhage	4	1	1	—	—	—	3	2	1	—	6	3
Other	1	—	—	—	—	1	—	—	—	—	1	—
Diseases of the circulatory system												
Heart disease	10	1	4	—	—	—	1	7	6	1	15	14
Coronary thrombosis	8	—	2	—	—	1	—	7	2	—	10	16
Aneurysm	1	—	—	—	—	—	—	1	—	—	1	—
Diseases of the respiratory system												
Pneumonia	1	—	—	—	—	—	—	1	—	—	1	1
Bronchitis	—	—	—	—	—	—	—	—	—	—	—	—
Other	—	—	—	—	—	—	—	—	—	—	—	1
Diseases of the digestive system												
Ulcer of the stomach or duodenum	—	—	—	—	—	—	—	—	—	—	—	—
Other diseases of stomach or duodenum	—	—	—	—	—	—	—	—	—	—	—	—
Appendicitis	—	—	—	—	—	—	—	—	—	—	—	—
Chronic enteritis and ulcerative colitis	—	—	—	—	—	—	—	—	—	—	—	—
Peritonitis	2	—	—	—	—	1	—	1	—	—	2	—
Cirrhosis of liver	—	—	—	—	—	—	—	—	—	—	—	—
Other diseases of liver	—	—	—	—	—	—	—	—	—	—	—	—
Diseases of pancreas	—	—	—	—	—	—	—	—	—	—	—	1
Other	—	—	—	—	—	—	—	—	—	—	—	—
Diseases of the genito-urinary system												
Nephritis and nephrosis	—	—	—	—	—	—	—	—	—	—	—	—
Diseases of the skin and cellular tissue	—	—	—	—	—	—	—	—	—	—	—	—
Diseases of the bones and organs of movement	—	—	—	—	—	—	—	—	—	—	—	—
Symptoms, senility and ill defined conditions	3	1	1	1	—	1	—	2	1	—	5	1
Food poisoning and excessive heat and insolation (including heat apoplexy, heat exhaustion and heat stroke)	—	—	—	—	—	—	—	—	—	—	—	—
Total	30	3	8	1	—	4	4	20	11	1	41	39

on board ships. His paper concentrates on description rather than an analysis and rests on assumptions, which in a British context are open to question.

Take for example the concept of nautical medicine. What exactly is this exclusive specialism? As a subject it is not taught in our medical schools; it is not the concern of any of our learned institutions; it rarely generates research activity; it has a very scanty literature; and its practitioners seldom if ever comment on the significance of available statistical data.

It would seem therefore that British nautical medicine, however defined, is a very tender flower. The reason for this could be the very restricted role of and the very limited resources made available to medical practitioners attached to the shipping companies. It could also arise from the low value the community generally places on occupational health. In this respect seafarers are probably no worse off than other groups of workers. However, whatever the constraints, the concept of nautical medicine deserves clear explanation, if only to avoid the accusation that it is a notion of little real substance.

Nautical medicine is said to be multi-disciplinary but what are these disciplines? By disciplines one presumably means academic disciplines, only one of which, ergonomics, is specifically mentioned. Shipwreck and survival, for example, constitute disasters rather than disciplines. so we need to know what these disciplines are which concern our nautical medical practitioners. Do they include physiology, psychology, psychiatry, pathology, epidemiology, statistics and sociology? If the disciplines are not identified how then can work in the various fields of interest referred to in Fig. 1 of the paper be systematically organised?

Nautical medicine may well be multi-disciplinary, but where are the practitioners of these various disciplines to be found? The work of shipping doctors ashore is dominated by medical examinations. The doctor afloat is preoccupied with treating individual cases. So one has to wonder when and how often this multi-disciplinary approach is actually applied for the purpose of realising nautical medicine's policy objectives, assuming of course that such objectives have been formulated.

The paper considers that the standards of fitness now required of UK mariners are very lenient in comparison with those which applied previously. This suggests that the previous standards were reasonably acceptable. A conservative view of this kind was held by many of Professor Goethe's British colleagues, and indeed many may still be of that opinion.

It is worth noting that despite the stringency of the former standards seamen still experienced health disturbances even though they had been passed fit. At the same time these standards prevented individual seamen, and seawomen, from remaining at work even though they were capable of work and represented no immediate risk to either themselves or others. The total embargo on the employment of seafarers with certain forms of cancer or of pregnant female seafarers in the short sea trades are examples of formal strictness which, in terms of occupational medicine, applied uniquely to seafarers.

The previous standards have been reviewed by specialists in occupational medicine from outside the shipping industry. The review doctors are widely experienced, highly qualified and highly regarded. The review was undertaken because of the disquiet and concern expressed by the National Union of Seamen and Members of Parliament in the House of Commons.

Following that review the revised standards came into play. It is acknowledged in the recently published report issued by the National Maritime Board that we can expect fewer redundancies on health grounds because of the beneficial effects of the new standards. In other words we are keeping officers and ratings, men and women, gainfully employed at sea, when if the standards had not been revised they would have been cast on the scrap heap.

At the same time there is no evidence to show that because the medical standards have been relaxed, doctors send people to sea when they should be kept ashore for treatment. Nor is there any evidence of seafarers who have benefitted from the application of the new standards having subsequently relapsed whilst on board ship. Whilst the present medical standards are not perfect they are now more compassionate and more flexible and that is the way they should stay.

Professor Goethe draws attention to the fact that as a result of technological change crews are smaller, and will be reduced even further in the years ahead. He also mentions that ships spend less time in port and consequently opportunities for leisure activity ashore are very restricted.

He might have gone on to say that seamen work extremely long hours, despite the advances made in ship operation and design. Compared with workers ashore, each week two of our seamen do the work of three and sometimes four men. This is inevitable given that seamen work anything from 60 to 80 h each week. No one, apart from the seamen and their unions, is the slightest bit concerned about the ill effects of these long hours, one of which is much greater exposure to the risk of being killed or injured at work. This state of affairs will not alter should automation bring crew numbers below present levels. It could therefore be concluded that technological advance will still keep seamen on the job seven days a week, ten and twelve hours a day.

Some might argue that the more advanced ships will require seafarers to be examined according to new and higher standards of physical and mental fitness. This would be necessary in order to lessen the risk of small crews being further reduced because of sudden death or serious illness.

Most officers and ratings enter seafaring in early manhood. Demanding higher fitness standards at the point of entry would not prevent health deterioration from the age of 35 onwards, which is when it most occurs.

Making the standards of fitness more rigorous would probably lead to more early retirements on grounds of ill health. The industry would therefore lose many experienced and qualified operatives and at the same time increase its retirement compensation costs. The seafarers concerned would be adversely affected, both socially and economically.

It is easy to pretend that seafaring as an occupation has no discernable influence on the morbidity of seamen. What is significant is that no one bothers to use the multi-disciplinary approach to find out. Yet the shipping companies pay out millions of pounds annually in compensation to employees prematurely retired because of their ill health. On present evidence the companies prefer to continue funding this enormous annual on-cost, whatever the size of a ship's crew, rather than spend money on discovering how to reduce the incidence of ill health among sea staff. This is a matter which might properly be regarded as being of direct interest to the industry's medical advisors.

Clearly the risk of death at work from physical or mental ill health will always be present in seafaring. Much more preventative action needs to be taken. In this regard it is significant that the importance of health education is not referred to in the paper, even though objectives are identified which require an educational programme in order to secure their fulfillment.

It is unfortunate that the role of the state in protecting the seafarer's health and safety has been overlooked in the paper. The numerous regulations now in force represent intervention by the state in order to protect seamen from the social irresponsibility of the privately owned shipping companies.

To the extent that the regulations demand the involvement of the nautical medical practitioner, that involvement is compulsory rather than voluntary. This does not take away from the professionalism with which doctors do their jobs. Rather it draws attention to the fact that without state

intervention the role of the doctor, as described by Professor Goethe, would be much diminished, with disastrous consequences for the health of seafarers.

J. McNAUGHT: I found the paper and its presentation interesting and instructive and it has made me realise how much development there had been in recent years in lifesaving equipment and methods of testing to ensure that the seafarer is adequately protected. I pay tribute to the skill of doctors and the research work done in an endeavour to keep seafarers healthy and reasonably immune from most of the diseases which can be contracted abroad, particularly malaria.

In earlier times, and from my own experience, the rule seemed to be 'If you can stand, you are not ill'. At sea, a person had to be obviously ill before he was allowed to miss a watch. Certainly, the Scottish senior engineers under whom I served had the same idea.

In 1941 during a voyage from Halifax to the UK in a troopship we had a 'flu epidemic on board and more than half the engineer officers were affected. On my watch the generator engineer and myself, the junior, were the only two out of five who were not ill. The other three still came down on watch and sat miserably for the 4+ hours of duty. In retrospect it was silly but it reflected the attitudes. Even the ship's doctor had little hope of demanding that someone stayed in bed.

The paper refers to seasickness, which was more often a cause for reprimand for being sick in the bilges than for sympathy.

The smaller crew is a problem if there is serious illness, but compared with the past it can generally be overcome by sending out a replacement, which is now much easier due to better communications and frequent air services.

There is often difficulty when equipping the medical chest on a UK registered ship built abroad, especially with drugs such as morphine.

In connection with noise and vibration, there have been several instances of engineer officers being influenced by the effect of these to give them a feeling of great insecurity and fear when inspecting the machinery alone during the night watches. Based on some French research on the effects of low-frequency vibrations on the body, I wonder if such vibrations could be a factor in the 'ghost' phenomenon referred to above? Has Professor Goethe any views on this?

In the section on keeping fit, I would like to ask Professor Goethe whether any studies have taken place on diet for seafarers arising from Surgeon Captain Cleave's book *The Saccharine Disease*, in which the author advocated the use of bran, wholewheat flour, fruit etc. and advised a reduction in the use of manufactured foods such as sugar and white flour. Ships' crews of course might not take kindly to such a change in eating habits.

Water supply was often a problem particularly on cargo ships and especially when they were anchored for some time in port or in estuarial waters: keeping the right degree of chlorination was important. Even then, algae could accumulate on the tank sides. In my experience the best tank coating was bitumen applied hot over a well prepared surface, but some shipyards refuse to adopt this method because of the fire risk during application.

Dr J. E. MORRIS (Institute of Naval Medicine): I agree with Dr Cowley that the data he presented on morbidity and accidents in British ships outline the importance of 'Western Civilisation' factors: stress, diet, lack of exercise, smoking and alcohol. The Royal Navy has also noted that of all the occupational groups, the chefs seem to be the most susceptible.

I would like to know whether the immersion suits Professor Goethe was testing had drain valves, and I can confirm the importance of the lifejacket with hood.

Is Professor Goethe training Chief Officers to use on board computer diagnosis?

In view of the many changes taking place in ships (the hazards from toxic substances, entering into confined spaces, new ideas in the procurement, treatment and storage of potable water, on board sewage treatment plants) is there not a need for an international reporting centre on incidents which may bear on the health and well being of mariners.

Dr B. NOLAN (Polytechnic of the South Bank): We should warmly welcome Professor Goethe's paper. Not only does it focus our attention on an important and under exposed aspect of seafaring, but it also demonstrates the complexity of the problems and the necessity of a multi-disciplinary approach.

As Professor Goethe reminds us, seamens' health was one of the earliest areas of occupational health to be studied. A glance at the history of seamens' health and safety shows the vast changes and improvements that have been achieved. Maybe we should remind ourselves that such changes do not merely occur but are achieved by peoples' endeavours. However, many serious problems remain. Some are old and some are new.

The application of science and technology has in many areas made seafaring safer. However, modern technology is not without its health costs as, for example, those who have served on high-speed diesel ships will know. Despite good food and well furnished cabins, to be subject to weeks of continuous noise and vibration is disturbing, stressful and probably harmful.

Some other problems are both ancient and modern. Quick turn around in port, small crews and long voyages lead to isolation. Seamen may be cut off from normal social life with its everyday stimulation, problems, pleasures and potential. Such isolation may in the long term lead to alienation and various health and development problems.

Seafaring is an exciting but inherently risky occupation. Work at sea, with all the dangers and uncertainties of weather, navigation, equipment and human fallibility etc., will always be dangerous. Risk cannot be eliminated but we must seek to reduce it.

Professor Goethe's paper is valuable in that it reminds us that the risks and problems of seamens' health need to be perceived and tackled on at least two levels, the structural or institutional level and the individual level. This is to say, health at sea requires care through the actions of government, shipping companies, unions, educational and research bodies, WHO and ILO agencies. Added to this must be the awareness and concern of the individual seaman in his own health and well being.

It is in this dual sense that we must today understand Sir Gilbert Blane's evergreen quotation of 1779 that Professor Goethe uses: 'More may be done towards the preservation of the health and lives of seaman than is commonly imagined; and it is a matter not only of humanity and duty, but of interest and policy'.

Dr P. SHIPLEY (Birkbeck College): I welcome Professor Goethe's paper. It is interesting from a historical point of view, is usefully descriptive, and sounds a timely and salutary warning about the problems of reduced manning on board modern ships. We seem to be some way off wholly remote or robot-controlled ships, and conditions for seamen are generally much better now than in the days of Captain Cook, but smaller crews may increase some of the burdens on the few individuals left.

I think Professor Goethe is correct in highlighting potential problems of monotony and workload variation. The stresses and pressures on seamen these days may be of a different order than before. Isolation and remoteness from land and home were presumably always potential problems at sea, but now, more than ever before, the responsible ships' officer cannot afford to get it wrong. With certain kinds of ships (gas

carriers, nuclear ships and others carrying highly dangerous cargoes) the consequences of human error, such as failing to detect and act appropriately on an important signal, could be catastrophic.

To guarantee the health of these responsible watchkeepers is clearly intrinsically worthwhile, but has double significance in the context of potential human error. It was right, I believe, that Professor Goethe should draw attention to the importance of maintaining physical fitness at sea, and that the lack of incentives to do so and scarcity of facilities on board is not unusual.

In a report on the health problems of ships pilots in the UK [see P. Shipley, *A Human Factors Study of Marine Pilotage*, Department of Industry Report, London (1979)] it was concluded that, despite some possible contributions made by the job of pilotage to the health of pilots, impaired health status and questionable lifestyles thought to have originated at sea and brough ashore by pilots entering the profession from the sea must form part of the whole aetiological picture.

Professor Goethe also draws attention to psychological fitness. Could this factor be given even greater consideration and thought paid also to interventions that might alleviate the problems of managing psychological as well as physical health? Ergonomic aids to watchkeepers go some way to preventing human error, as do training, advice and education in psychological and human factors principles.

Helpful resources could also include a social factor. If crews cannot go to a ship's doctor or a welfare officer with personal problems, who do they go to? Perhaps the bridge officer(s) trained in elementary medicine referred to by Professor Goethe should also be equipped with psychological knowledge and the skill to weld a crew together into a working team of individuals prepared also to help their crewmates with personal difficulties.

To the outsider the ship's environment is striking in the seeming 'artificiality' of its social life, and the way in which work and non-work life (recreation?) overlap. Do the shipping companies of the advanced nations need to take the lead here in modelling behaviour for others?

Surgeon Commander T. A. TURNBULL (Retired, Honorary Medical Adviser MNAOA, 1962–1981): Perhaps reference should be made to *Medicine and the Navy 1200–1900*, Vols I and II, edited by J. J. Keevil and Vols III and IV, edited by C. Lloyd and J. L. S. Coulter, published by E. S. Livingstone Ltd (1957–1963).

There is mention of a lowering of medical standards in the UK in recent years. This is not altogether confirmed at Ocean Air House (MNAOA) and should perhaps be checked.

There appears to be no mention of pollution in ro–ro ships; although this is more a psychological than a physiological problem for crews it may be worth a mention. The problem was reviewed in the MNAOA publication *The Telegraph* in August 1979.

Surgeon Vice-Admiral Sir JAMES WATT (Royal Society of Medicine): Professor Goethe attempts to cover so large a field that the generalizations he is compelled to make do not permit him to explain the complexities of the problems he outlines. This is particularly true in his historical introduction and the environmental section appears to owe more to the author's personal interests than to current research in this field by the Royal Navy and US Navy medical scientists. This is probably because the paper is biased towards the mercantile marine rather than the fighting services, although, as Professor Goethe has shown, all the significant advances came from doctors associated with the Royal Navy. Nevertheless, within the framework Professor Goethe has chosen, the paper provides an admirable general review of the development and current problems of health care on board ships.

I have just one or two points of detail. Sanitary arrangements were not generally as bad as Professor Goethe suggests on page 2. So much depended upon the individual commander and from the sixteenth century onwards examples abound of commanders who insisted upon the strictest possible standards of hygiene, personal cleanliness and cleanliness and ventilation of the ship.

It was Samuel Wallis, not Cook, who first introduced the three-watch system and both Wallis and Cook followed strictly the regime laid down by Dr James Lind, who first established the principles for health at sea. These principles were communicated to naval captains either directly or through their surgeons by influential disciples of Lind.

Iron ships also brought their problems: heat from the engines, condensation on the mess decks and cross-infection through the ventilation systems. This led to a sharp increase in rheumatism and respiratory diseases, notably tuberculosis. Resistant infections associated with malaria and venereal diseases constitute a modern hazard.

Finally, the Royal Navy Institute of Naval Medicine, together with its US counterpart, is currently pursuing, with material advances in the field of preventive medicine, active research programmes into environmental and psychological stress and selection procedures.

I do not understand Professor Goethe's mortality figures for 1760. Were these meant to be morbidity rates? Only 1 in 8 sailors in the Royal Navy died during the latter half of the eighteenth century. By the end of the nineteenth century, mortality from disease had been reduced to 1 in 143, chiefly because of the effects of vaccination, quinine prophylasix for fevers, antiseptic treatment of wounds, the conquest of scurvy and some improvements in the sailors' diet.

Author's reply

My paper was intended to give a general survey of the various aspects and problems of nautical medicine and as such does not claim to be comprehensive. I wished to give a general survey to a mainly non-medical but seafaring audience, and I wished to highlight and to expand upon topics of special interest. A specialist paper for historians, medical doctors or even nautical medical doctors was neither my intention nor requested by The Institute of Marine Engineers. I was therefore surprised by the number of contributions from those involved in nautical medicine, naval medicine, government and unions, and thank them for their factual clarifications and amendments.

Captain Beck justly points out that the historical part of my lecture refers mainly to the military side, while the section headed 'Nautical Medicine Today' deals only with merchant shipping. As already pointed out, the paper was addressed to marine engineers involved in mercantile seafaring, and also the history of nautical medicine is based mainly on military nautical medicine. This is quite evident from the four volumes of *Medicine and the Navy* edited by J. J. Keevil, C. Lloyd and J. L. S. Coulter. I know of no similar publication for the merchant marine.

Whilst being grateful for Captain Beck's summary of present-day nautical medicine on the military side, I cannot accept his general comments regarding 'contradictory statements'. The specific recommendations are based on the results of my own or other published work as well as on practical experience, and not on 'myths and misconceptions about naval service'.

The mention of the Merchant Shipping Notice No. M1114 of the Merchant Shipping (Medical Examination) Regulations 1983, SI 1983, No. 808 by Mr Boddie seeks to amend my paper, which was intended to be a general survey rather than a specific report on the situation in the UK. In

Notice No. 808 it is explicitly stated that the initial examination has to be stricter than the examination for retention, where more flexibility should be exercised. It also has to be mentioned that the intervals of examination between 18 and 40 years of age are usually 5 years and not the 2 years stipulated by ILO Convention 73, which is followed in most other seafaring countries. Only after 40 years of age is this 2 year interval betweeen examinations introduced in the UK.

The investigations of the *Mary Rose* have produced results of great interest about life on board ships and nautical medicine in the sixteenth century. The ship and her crew, however, had not been at sea for long, which may explain the quite good state of health of the seamen. Reports of ship's doctors and naval surgeons at other times and other periods often show a quite different picture, with considerable deficiencies and malnutrition, particularly during long foreign voyages.

The question of fibre in our diet today is a controversial one among nutrition physiologists. The opinion tends towards a higher proportion of fibre in the diet to improve the filling of the intestines and to shorten the passage time. A short passage time and well filled intestines mean shorter periods of contact of carcinogenic substances, which seem to be unavoidable in many foods, with the intestinal mucosa, with a comcomitant reduction in the danger of carcinomas.

I thank Dr Bowden for mentioning the Chemical Supplements of *The Ship Captain's Medical Guide* and the current Merchant Shipping Medical Scales. The new *The Ship Captain's Medical Guide* is undoubtedly one of the best shipboard medical guides that can be found.

The medical education of a ship's officer or anyone else who has to carry out medical care on board ships is very important and must never be neglected. At least one crew member of each ship (officer, catering officer, radio operator or whoever) should receive basic medical training with refresher courses at regular intervals. As far as I know, refresher courses are mandatory only in France, whilst in several other seafaring countries (USA, UK, Federal Republic of Germany) they are recommended and offered but not mandatory. I agree with Dr Bowden that catering officers or other officers who have not received any medical training but may have to treat the sick and injured should be required to obtain the same medical training certificates.

I should like to thank Professor McCallum for mentioning the famous experiments of the late Professor Pask. These experiments and his scientific approach have not been forgotten. My Institute has adopted the immersible dummy developed by Professor Pask and it is still being used for the evaluation of lifesaving appliances and will in future be used for rough-water testing of survival suits. Professor McCallum rightly pointed out the necessity of such investigations.

The question of health education for seafarers concerning cigarette smoking and alcohol consumption is hard to answer. Many seafaring nations, onshore organisations and shipping companies mount education campaigns. Here, as far as I know, anti-alcohol propaganda plays the main part. It cannot be denied that this is a major problem in safety on board ships and legislation may be required. Most countries have set strict limits in alcohol consumption for road traffic drivers whereas, as far as I know, there are no such regulations for seafaring. It is said that the captain or the watchkeeping officer should be sober, but without set limits the term has no useful and practical application.

The statistics submitted by Dr Crowley regarding deaths of seafarers are very interesting, and it is remarkable that deaths caused by diseases are much more frequent than fatal accidents. Most mortality statistics from other seafaring countries (e.g. Italy, Denmark, USA) only consider deaths on board. Here too disease is the major cause of death, but not to such a large extent as in the UK. The comparable set of statistics of the Federal Republic of Germany are not as detailed as those of the UK and only deal with fatal accidents. A comparison of the statistics of different countries would be interesting.

A comparison with shore workers appears to be very difficult as it is hard to find a specific group of workers who are comparable with seafarers. Various groups of professional shore workers have quite different mortality statistics. For dock workers in the Federal Republic of Germany illnesses clearly predominate over accidents as the cause of death.

Dr Cowley contests my views and defends the latest set of medical standards for UK seafarers. In my opinion they are more 'flexible' but what they have gained in flexibility they have lost in clarity and uniformity of decisions. Incidentally, if coronary disease accounted for 68% of deaths in 1974–1983, it seems inappropriate to relax the medical standards for the cardiovasular system and the associated precursor diseases. I still feel that the new standards are more 'lenient' than those they replaced and those of some other seafaring countries. Indeed what else was the purpose of the December 1983 review if not to reduce standards?

Dr Dean also points to the value of the new mandadory medical examination regulations. One can only agree with his statement that a very 'important point is that the standards are now uniform and legally enforceable when previously this was not the case'. Of course, it is good to give the doctor in charge of pre-employment examinations a certain liberty of action, but there should be clear statements on serious diseases which in all cases should result in 'unfit for duty at sea'.

Only doctors with great experience in this field and familiarly with the situation on board ships can come to a correct decision with 'lenient' or 'flexible' standards. If there are no clear definitions there may be very different outcomes in similar cases with subsequent problems on board ships.

The sequence of seamens' diseases according to the international classification shown in Fig. 2 of the paper refers to the frequency of diagnoses (morbidity). The mortality statistics show quite a different picture. While most diseases do not lead to death, the death risk with diseases of the circulatory system is much higher. This explains why in the mortality statistics for seafarers in the UK cardiovascular diseases (probably cardiac infarction mainly) are so frequent, while in our sequence of seamens' diseases those of the circulatory system have a frequency of 4.8%. See also my reply to Dr Cowley.

The high rate of coronary deaths is worrying. It is a great pity that the major epidemiological study commissioned by the National Maritime Board several years ago lapsed due to lack of participation.

I am glad that Mr Duggan mentions the necessary cooperation between marine engineer and medical doctor. In my Institute in the Department for Nautical Medicine we try to practise this cooperation, with some success. Thus we have a marine engineer within our group who was himself at sea for many years and a ship construction engineer (naval architect).

The cooperation is very fruitful, especially in the fields of ergonomy, toxicology, investigations of noise and vibration on board etc.

Regarding the stress factor investigation mentioned by Mr Duggan, stress on the crew caused by noise and vibration, as evaluated by the ketosteroid technique, is an example for possible cooperation. However there must be good coordination and understanding between medicine and engineering. My Institute is ready and willing to follow up interesting proposals.

I will not argue with Mr Kinahan when he states that my paper is not based on analyses but on assumptions, because this cannot be proved. However, I agree with him that nautical medicine does not play a large role in the UK at the moment, unlike in former times. The famous naval doctor Thomas Trotter stated in his book *Medicina Nautica, an Essay on the Disease of Seamen* (published in 1793) 'Dr Lind may be justly styled "the father of nautical medicine"'.

The term 'nautical medicine' was quite familiar elsewhere and it was a recognized discipline, and as Dr William Turnbull wrote in his book *The Naval Surgeon* about the eighteenth century 'At this time the study of nautical medicine may be said properly to have begun'. The term 'naval medicine' in questions related to the health of military seafarers has been used in the UK for a long time, and Drs Lind, Blane and Trotter, as well as other historic and contemporary authors, have used it constantly. The name of the 'Institute of Naval Medicine' of the Royal Navy, where there are professorships and a Dean of Naval Medicine, proves my point.

Mr Kinahan also asks about the multi-disciplinary nature of nautical medicine. It goes without saying that nautical medicine requires knowledge in physiology, psychology, pathology, epidemiology, statistics etc.

The comments of Mr Kinahan are interesting as offering a view of nautical medicine as seen by an Officer of The National Union of Seamen.

Mr McNaught underlines a very interesting point that has not been taken sufficiently into consideration when discussing the frequency of diseases: the fact that in former times illness was no excuse for missing duty periods. One simply could not stay in bed even if it was a more serious and feverish illness. In line with the more understanding attitudes ashore today, the situation in shipping has also changed. Definitely 'hardiness' used to be much more self-evident than now, but I think that even today on board ships of developed countries one is less 'unfit for duty' than when ashore.

The 'ghost phenomenon' mentioned by Mr McNaught could be caused by low-frequency vibrations, especially with overfatigue. The very-low-frequency vibrations could result in the feeling at certain parts of the body of having been touched by a 'ghost'.

Surgeon Captain Cleave's book *The Saccharine Disease* is not known to me. The recommendation to eat bran, whole wheat flour etc. and to reduce the consumption of manufactured foods such as sugar and white flour is a general nutrition recommendation. Such advice, of course, is hard to follow on board ships. We are well aware of this problem, especially if one tries to give advice to ships' cooks to maintain a diet without an excessive calorific value. Often the crew does not agree to such menus.

The question of the best possible coating for drinking-water tanks can not be answered. In ships various coatings such as cement–waterglass, bitumen, plastic of various kinds etc. are still found, and all have advantages and disadvantages.

Dr Morris' statement that 'the Royal Navy has also noted that of all occupational groups, the chefs seem to be most susceptible' is quite important. In all working fields of developed countries the performance-orientated and management personnel (whether craftsmen, technicians or scientists) are especially endangered by stress, harmful diets, smoking and alcohol.

During tests on immersion suits several types with drain valves were used. When testing life-jackets the Royal Navy model with hood was clearly superior to the others in reducing the frequency of mouth and nose flooding in rough sea. Regrettably this knowledge has yet to be put to practical use. It is highly desirable that the responsible authorities should stress the use of this device, which can easily be added to existing types of life-jackets.

Computer diagnosis in the medical training of Chief Officers and licencees has not been introduced in Hamburg. We do not have very much experience in this field, but we believe that it could be used in connection with radio medical advice.

I can only agree with the idea of an international reporting centre of the sort mentioned by Dr Morris. It would be very helpful to have a centre where all relevant information could be collected and by means of which exchange of experience would be possible. In my Institute we try to collect such information on an informal basis and to keep the information available to the public.

Dr Nolan is an experienced socio-psychologist and has published extensively on seafaring and its risks. One can only agree with his opinion that contemporary and, even more so, future shipping will throw up additional psychological problems caused by isolation because of reduced crew numbers. It will probably be necessary not only to carry out general fitness examinations but also to study the mental stability and personality of seamen and then try and keep those who find loneliness and isolation hard to bear away from seafaring.

Dr Shipley is most experienced in workload studies in seafaring and piloting, and she has investigated the psychological problems of seafaring today, with special emphasis on the stresses caused by isolation and remoteness from land and home. The cut-off from psycho-social relationships ashore is quite evident and acknowledged, as far as we can see, by seamen.

It happens quite frequently that seamen who have been travelling for a long time totally cross out (so to say) in their life calendar the period at sea and 'live' only during the period of leave. At sea they simply 'vegetate' towards their leave.

Dr Shipley also mentions the important fact of psychological fitness. Her point that officers should have psychological knowledge as well is very important, and one should at least try to make a start in this field. I quite agree that studies on the psychological aspects of seafaring, especially of psychological fitness, are necessary.

Commander Turnbull, a very experienced naval surgeon and also acquainted with the situation in the merchant marine, mentions the four volumes of *Medicine and the Navy* edited by J. J. Keevil, C. Lloyd and J. L. S. Coulter. This standard work on the history of naval medicine and military seafarers' health in Great Britain has no parallel. It is, I think, the most comprehensive work of its kind ever written. The French Navy also had excellent physicians, especially in the eighteenth and nineteenth centuries, and famous academies for naval doctors. The French Navy had a very high hygiene standard. There are quite a number of individual publications on this subject, but unfortunately not such a comprehensive work as that mentioned above.

Commander Turnbull mentions pollution on ro–ro ships. I think he means air pollution caused by the engines of road tractors, lorries etc. at roll-on/roll-off decks. This undoubtedly is a big problem and can be solved only by adequate ventilation. Various investigations of this problem have been carried out. If sufficient ventilation devices are installed, and especially if they are arranged in an optimum layout, it is possible to keep the exhaust fumes at a tolerable level.

As a well known expert in the field of naval history, Sir James Watt explains some historical aspects of the British Navy. He says that Samuel Wallis and not James Cook introduced the three-watch system first, according to the advice of James Lind (a historical fact that cannot be ignored) but I tried to point out that James Cook practised the three-watch system widely and commented on it subsequently

rather extensively.

I agree with Sir James Watt that there were 'healthy ships' in the navies if (by strict hygiene and control by the commander) cleanliness, ventilation and health care were perfect. An example were the voyages of James Cook, who lost very few people to disease. But these voyages, I think, were exceptions compared with other ships of the Royal Navy, other navies and merchant seafaring worldwide.

Rouppe in *De Morbis Navigantium*, for example, writes in 1764 about the situation on Dutch vessels: 'At sea they go on watch, in the port as well, if the ship rides at one anchor only. If she rides at two anchors, only half of them go on watch. As there are not only young and strong men among the crew but many old and worn-out you can imagine how such a living influences them, especially in bad weather. Then these old and miserable people hide in dirty corners and stay there, hidden, unless they are compelled to see a doctor or they are pushed out by their comrades because of their vermins. And it does happen that you can see people on board ships in the middle of winter when it is bitterly cold in torn linen garments without underwear, bare skin visible through the holes. Because in addition to that hammocks and blankets are missing. They have given away everything for liquor. These are the people prone to scurvy first'.

In the same period, Clark wrote in 1778 'If the ships are detained for a long period by unfavourable winds in cold and stormy weather, especially if the sea constantly floods the deck, certainly the condition of a simple sailor is miserable, because if he has to go on watch he is wet and weak and if he goes downstairs there is no other place where to go than a dirty nest and a wet hammock'.

Other authors reported similar circumstances.

The mortality figures of 1760, 1810, 1878 and 1940–1949 are per thousand. The figures for 1760 show 125 dead per 1000 active sailors. This exactly corresponds to Sir James Watt's figure when he says 'only 1 in 8 sailors of the Royal Navy died during the latter half of the eighteenth century'. The table of distribution of diagnoses is based on a report by Lind in the year 1767 which referred to patients in the Haslar Naval Hospital.

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